CDF Central Preshower Detector Upgrade for IIb

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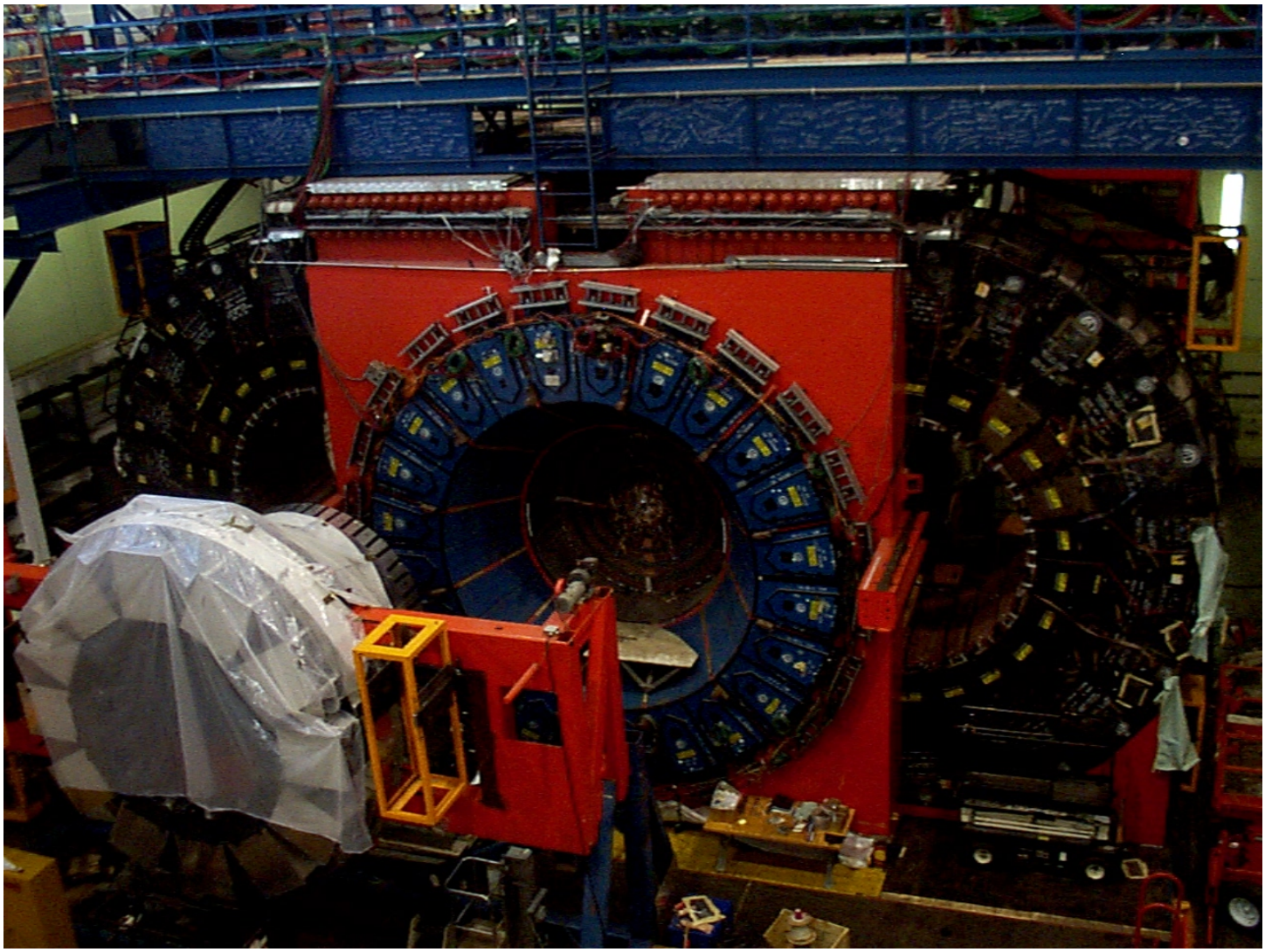
Motivation

Baseline Design Parameters

Integrated Crack Chamber Upgrade

Cost and Schedule

Preshower Basics



Lies behind 1.1X0 of
dead material (solenoid coil) and
in front of EM Calorimeter

Motivation

CDF Preshower used in >100 papers, about 1/2 of all Run I publications

Includes Higgs Search, Sin(2β), High Pt Photons, Top Quark Mass

Three principle uses so far:

High Pt Electron ID

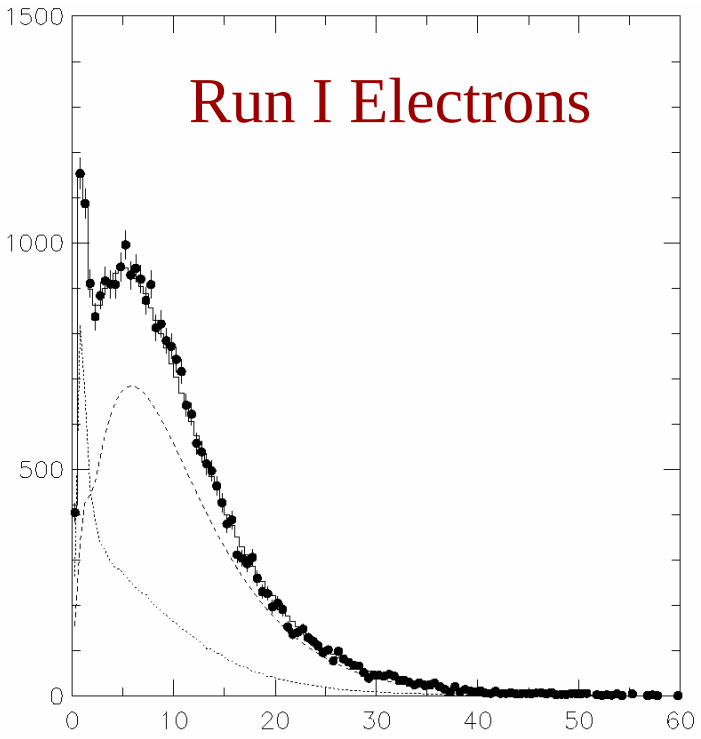
Soft Electron b-tagging

Photon Background Subtraction

Preshower Uses for Run II Higgs Detection

High Pt Electron ID

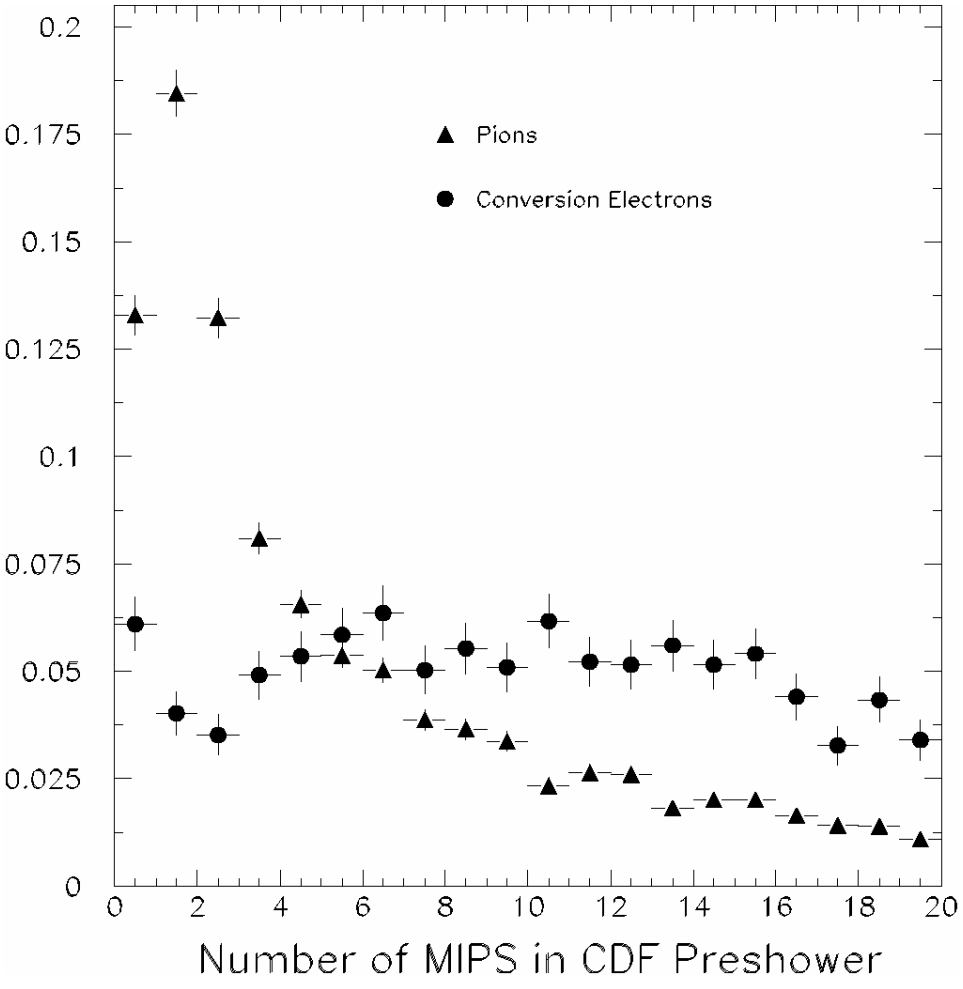
MIP Peaks give a remarkably clear picture of backgrounds



Preshower Uses for Run II Higgs Detection

Soft Electron b-tagging useful for the "loose" b-tag of a double tag

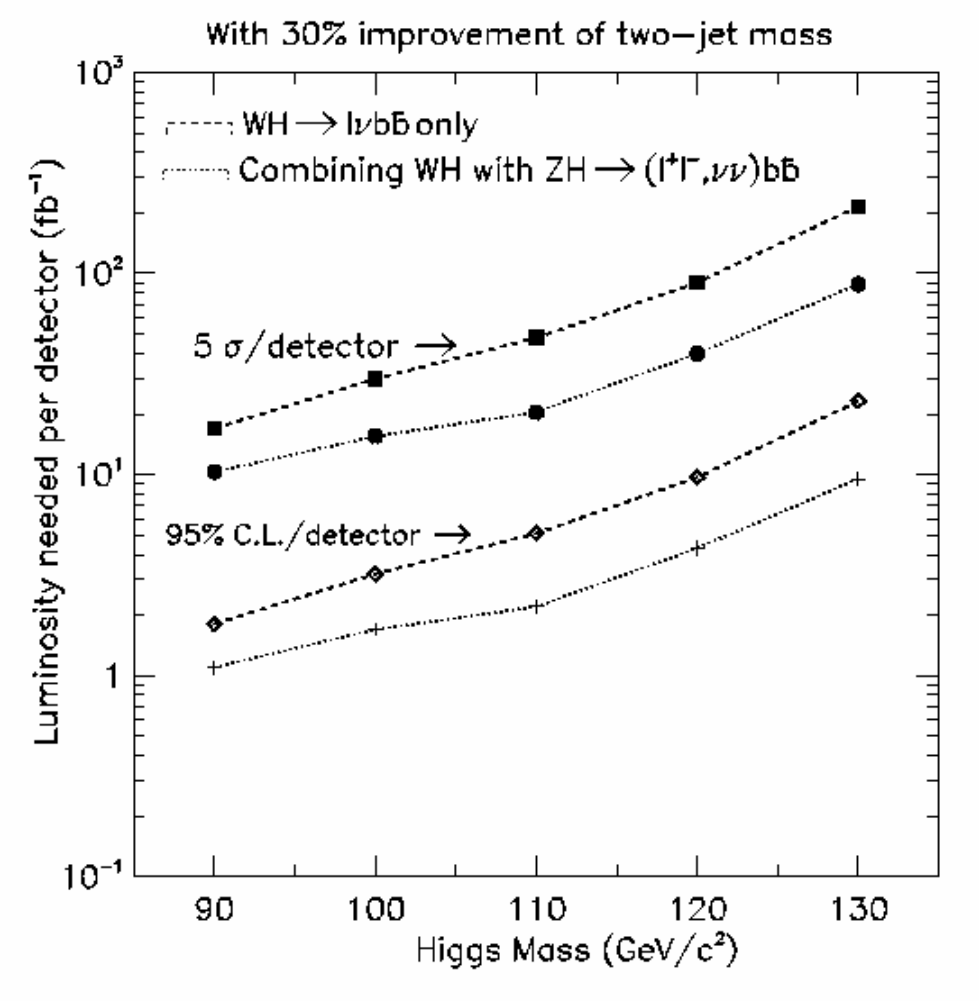
This plot of 2 GeV particles is from the original top quark "evidence" paper...



Preshower Uses for Run II Higgs Detection

Jet Energy Resolution is an important component of Higgs searches

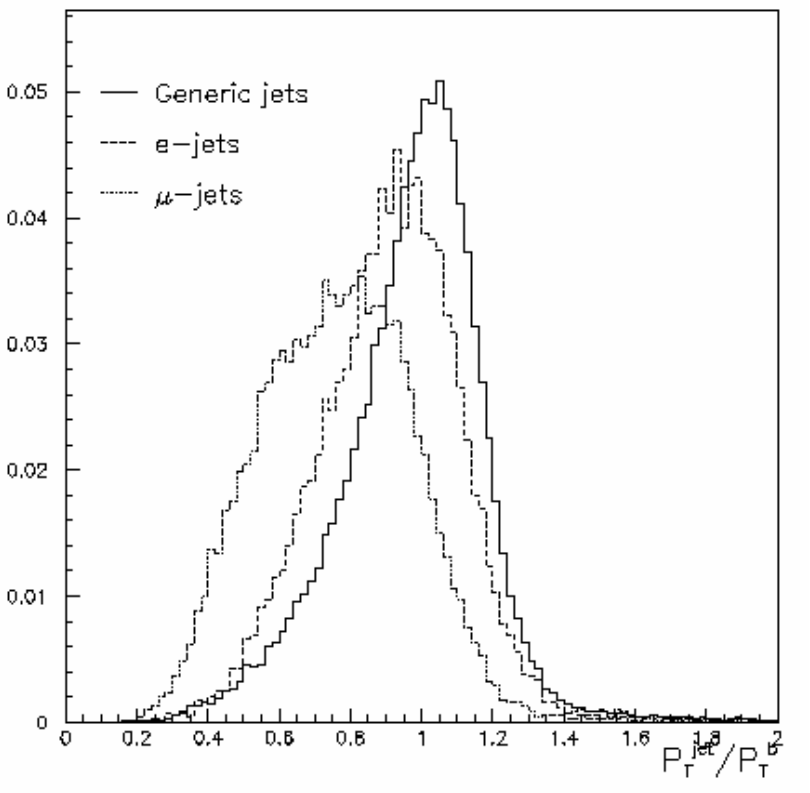
Most analyses assume improved resolutions compared to Run I



Preshower Uses for Run II Higgs Detection

Soft electron b-tagging useful for neutrino corrections

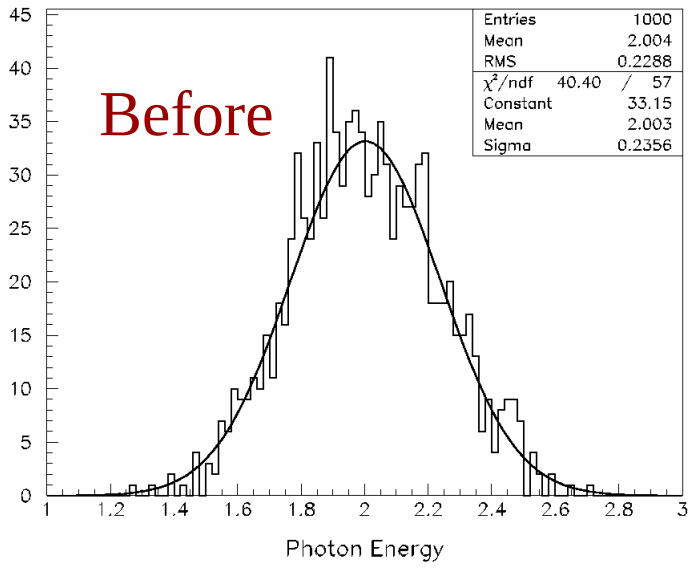
Studies underway to improve the tagging efficiency by lowering Pt threshold below 2 GeV, need Preshower discrimination

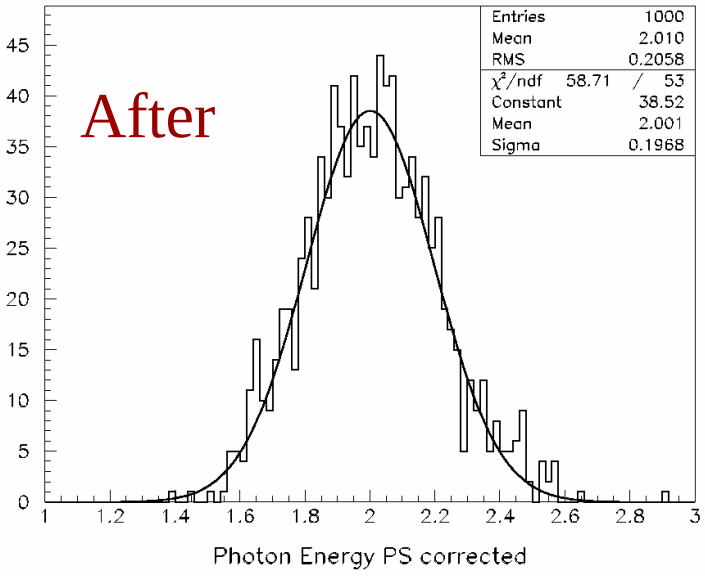


Preshower Uses for Run II Higgs Detection

Recent ZEUS collaboration study improves jet resolutions by 17% using Preshower energy corrections for soft photons and pions

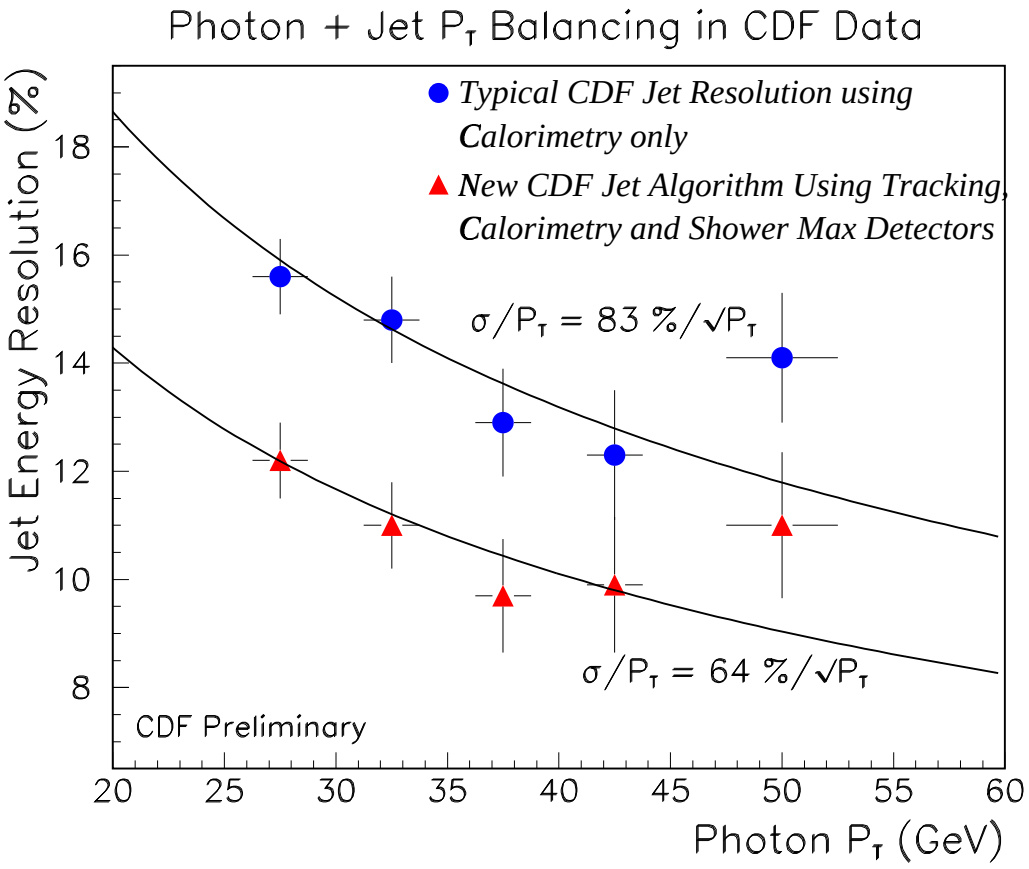
CDF Preshower GEANT simulation of 2 GeV photons shows 20% improvement





Preshower Uses for Run II Higgs Detection

One of the Main Challenges of "Energy Flow Algorithms" is estimating the fraction of track energy deposited in the EM calorimeter, Preshower should help...



Preshower Uses for Run II Higgs Detection

Summary:

High Pt Electron ID

Soft electron b-tagging

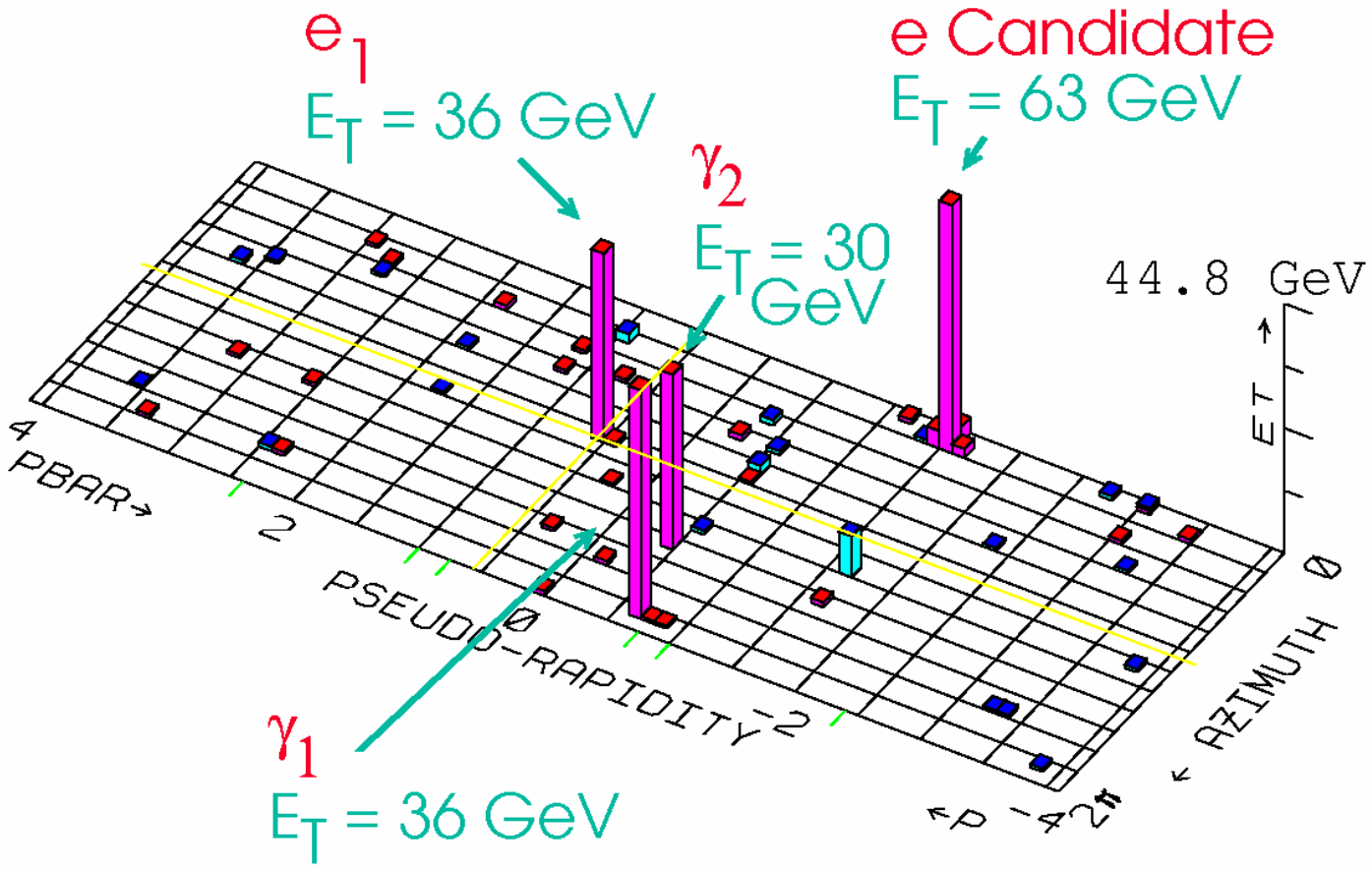
Soft electron b-tags for neutrino corrections

Photon energy resolution improvement

A component of Energy Flow Algorithms

But forget the Higgs, all the Fun is in Photons

$ee\gamma\gamma\not{E}_T$ Candidate Event



$\not{E}_T$ = 55 GeV

SM Background estimate of 10^{-6}

If an Early Sign of New Physics, then likely to have many channels with High Pt Photons

$$\tilde{C}_1\tilde{N}_2 \to (jj\tilde{N}_1)(\gamma\tilde{N}_1) \to \gamma jj\not{E}_T$$

$$\tilde{C}_1\tilde{N}_2 \to (\tilde{t}_1 b)(\gamma\tilde{N}_1) \to (c\tilde{N}_1 b)(\gamma\tilde{N}_1) \to \gamma bc\not{E}_T$$

$$\tilde{g}\tilde{C}_2 \to (q\bar{q}\tilde{N}_2)(\tilde{t}_1 b) \to (jj\gamma\tilde{N}_1)(cb\tilde{N}_1) \to \gamma bcjj\not{E}_T$$

$$\tilde{g}\tilde{N}_2 \to (q\bar{q}\tilde{C}_2)(\gamma\tilde{N}_1) \to (jj\tilde{t}_1 b)(\gamma\tilde{N}_1) \to \gamma bcjj\not{E}_T$$

$$\tilde{g}\tilde{g} \to (q\bar{q}\tilde{C}_2)(q\bar{q}\tilde{N}_2) \to \gamma bcjjjj\not{E}_T$$

Preshower is the Only Model-Independent Background Subtraction Method above 35 GeV

For example, Isolation distributions will be quite different for the following signals due to different number of jets.

$$\tilde{C}_1\tilde{N}_2 \to (jj\tilde{N}_1)(\gamma\tilde{N}_1) \to \gamma jj\not{E}_T$$

$$\tilde{C}_1\tilde{N}_2 \to (\tilde{t}_1 b)(\gamma\tilde{N}_1) \to (c\tilde{N}_1 b)(\gamma\tilde{N}_1) \to \gamma bc\not{E}_T$$

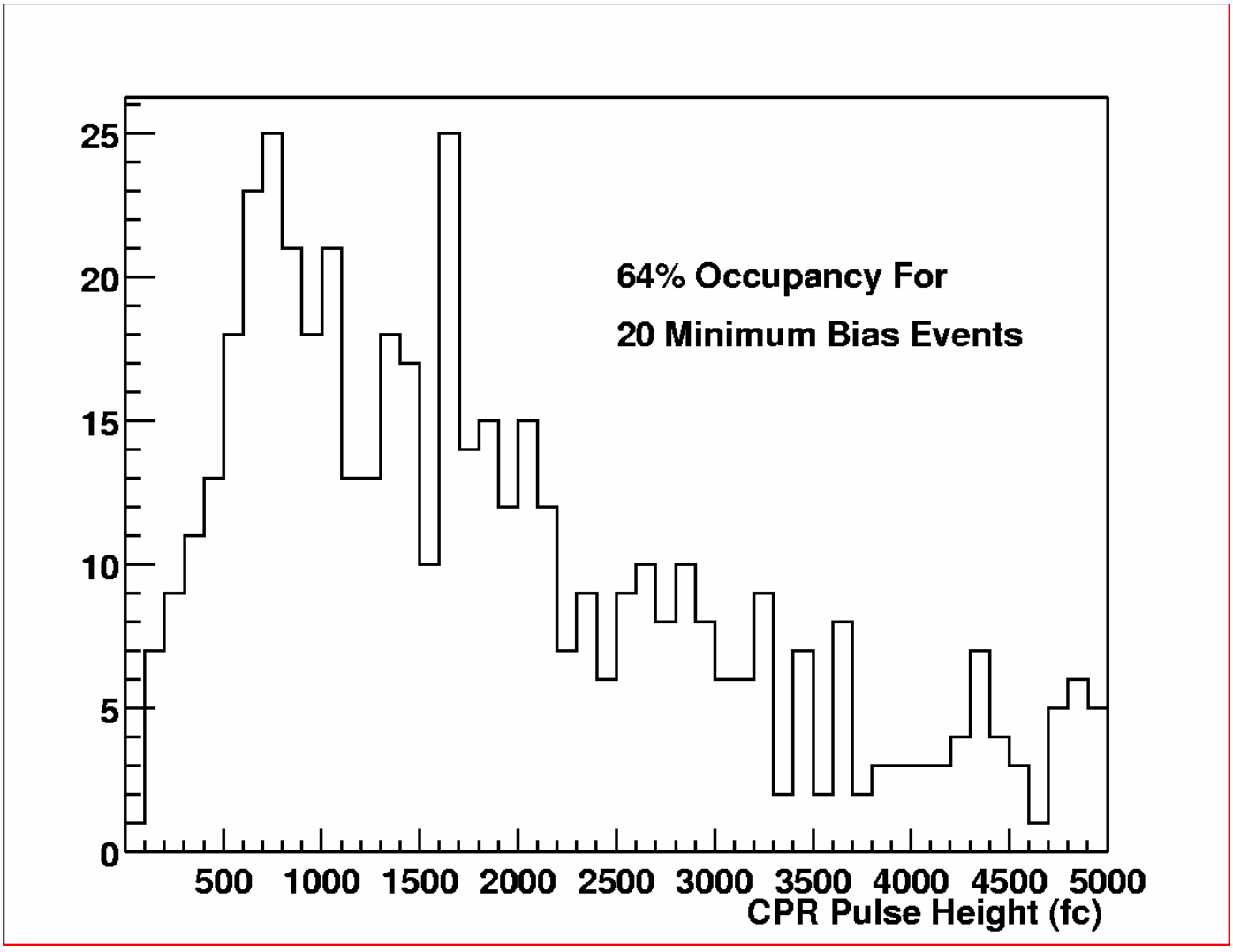
$$\tilde{g}\tilde{C}_2 \to (q\bar{q}\tilde{N}_2)(\tilde{t}_1 b) \to (jj\gamma\tilde{N}_1)(cb\tilde{N}_1) \to \gamma bcjj\not{E}_T$$

$$\tilde{g}\tilde{N}_2 \to (q\bar{q}\tilde{C}_2)(\gamma\tilde{N}_1) \to (jj\tilde{t}_1 b)(\gamma\tilde{N}_1) \to \gamma bcjj\not{E}_T$$

$$\tilde{g}\tilde{g} \to (q\bar{q}\tilde{C}_2)(q\bar{q}\tilde{N}_2) \to \gamma bcjjjj\not{E}_T$$

And the Run I Preshower Detector will not survive Run IIb

A slow gas chamber that integrates over 4 crossings, with 5 minimum bias events per crossing that's 20 minimum bias events.



Run IIB Baseline Detector Specs

Joey Huston (MSU) -- co-project leader

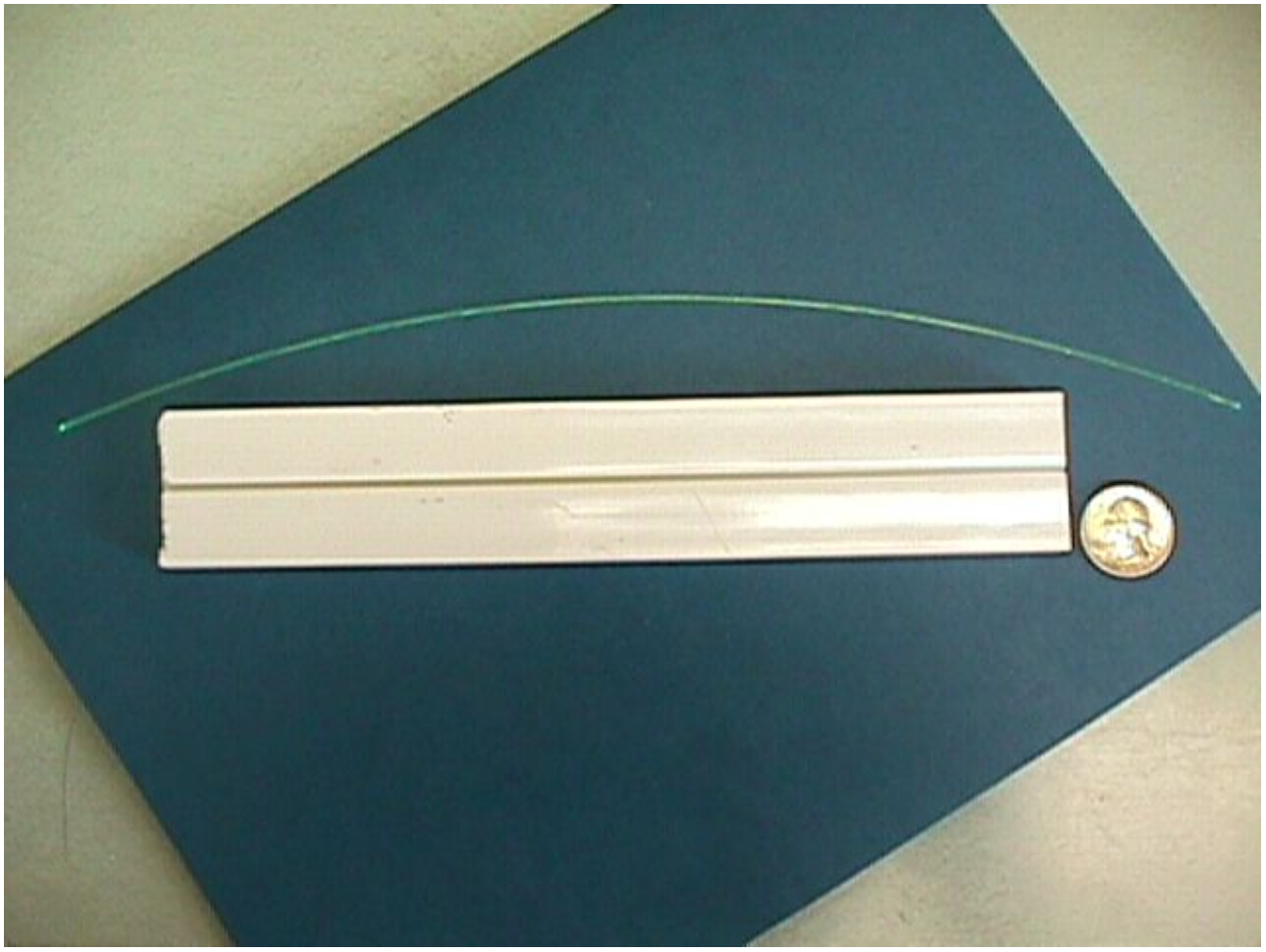
Reuse existing electronics

“Recycle” Excess Minos Scintillator

Use the same 16-channel phototube as the CDF Endplug Preshower

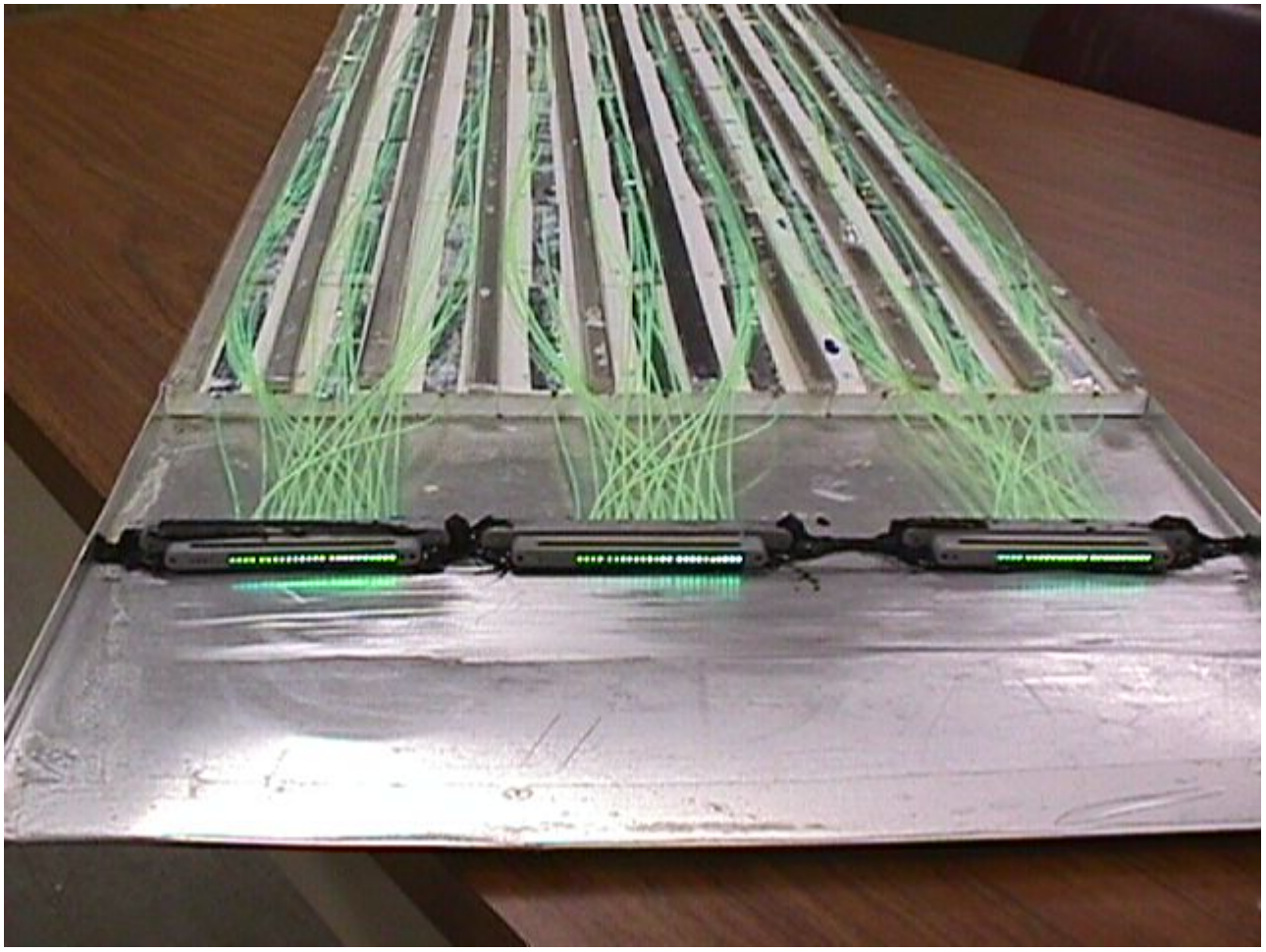
Project is almost completely defined with these three requirements...

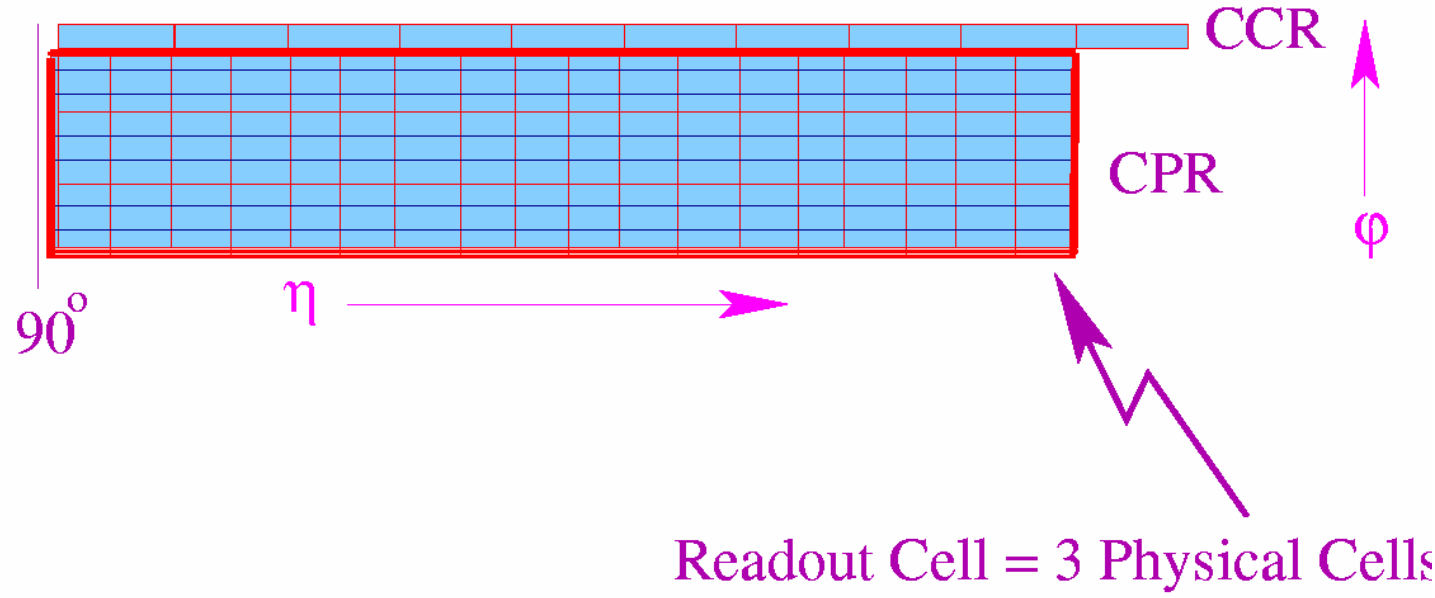
Excess Minos Scintillator Strip

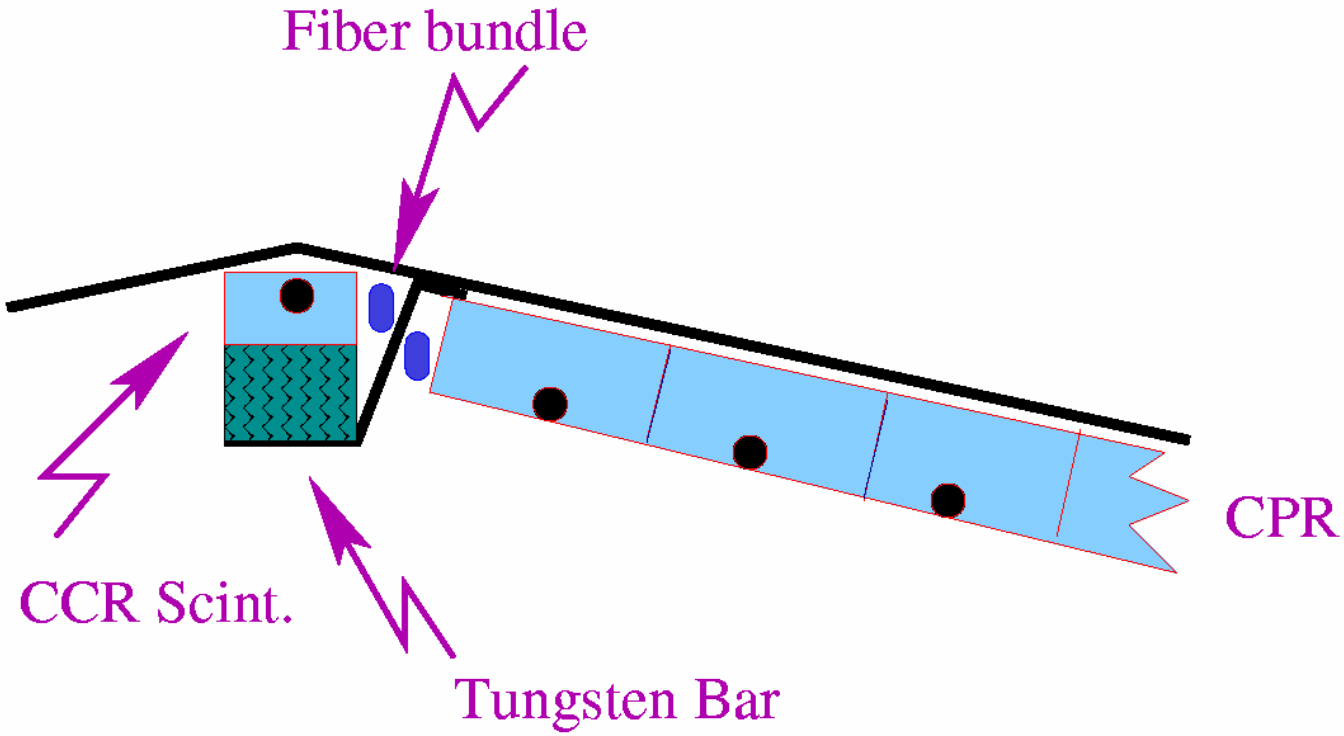


Initial Prototype Built at ANL

Initial Prototype Built at ANL




CCR
CPR
φ
90°
η
Readout Cell = 3 Physical Cells


Fiber bundle
CPR
CCR Scint.
Tungsten Bar

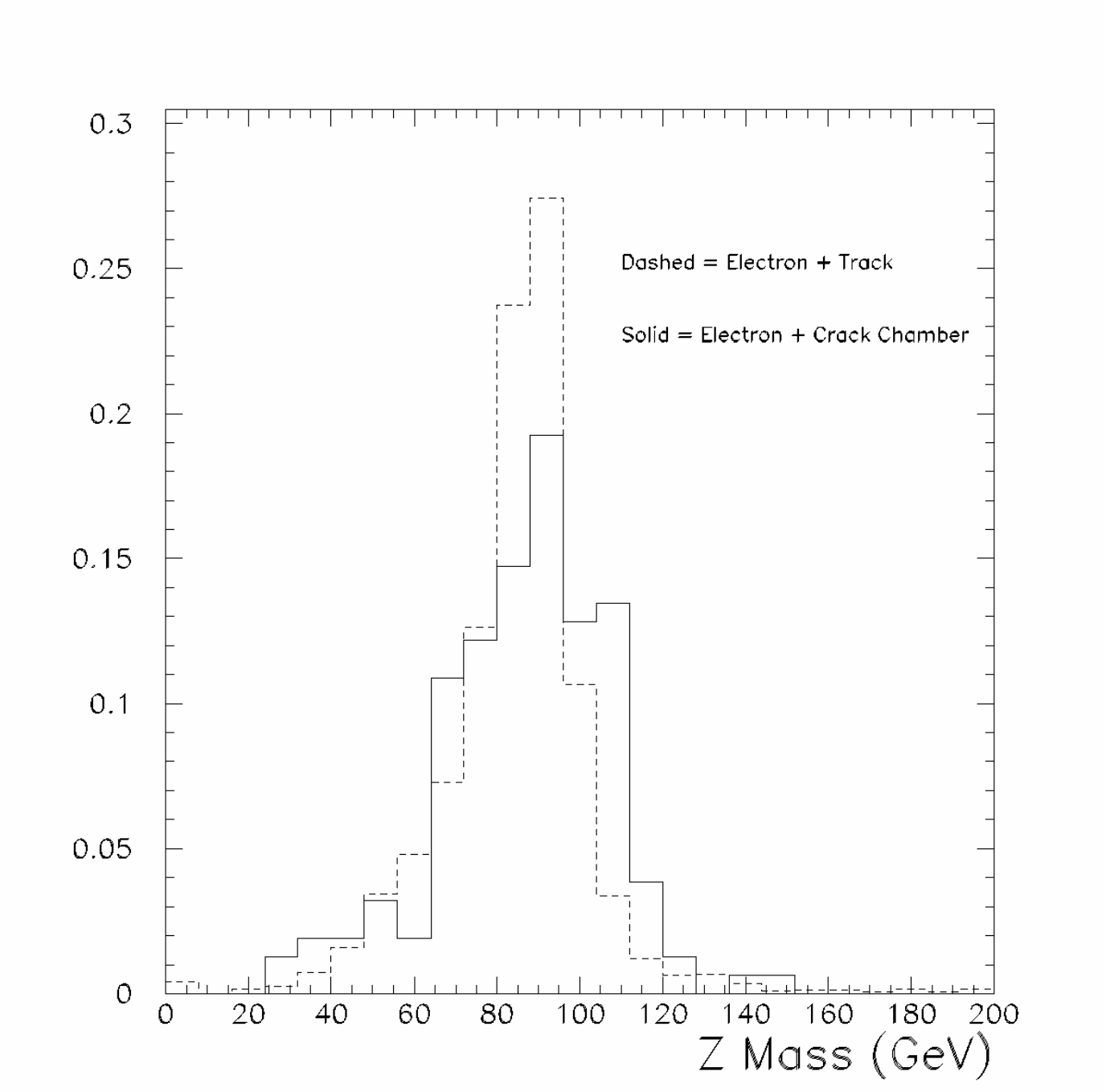
Located next to CPR are more gas chambers, Crack Energy Detectors

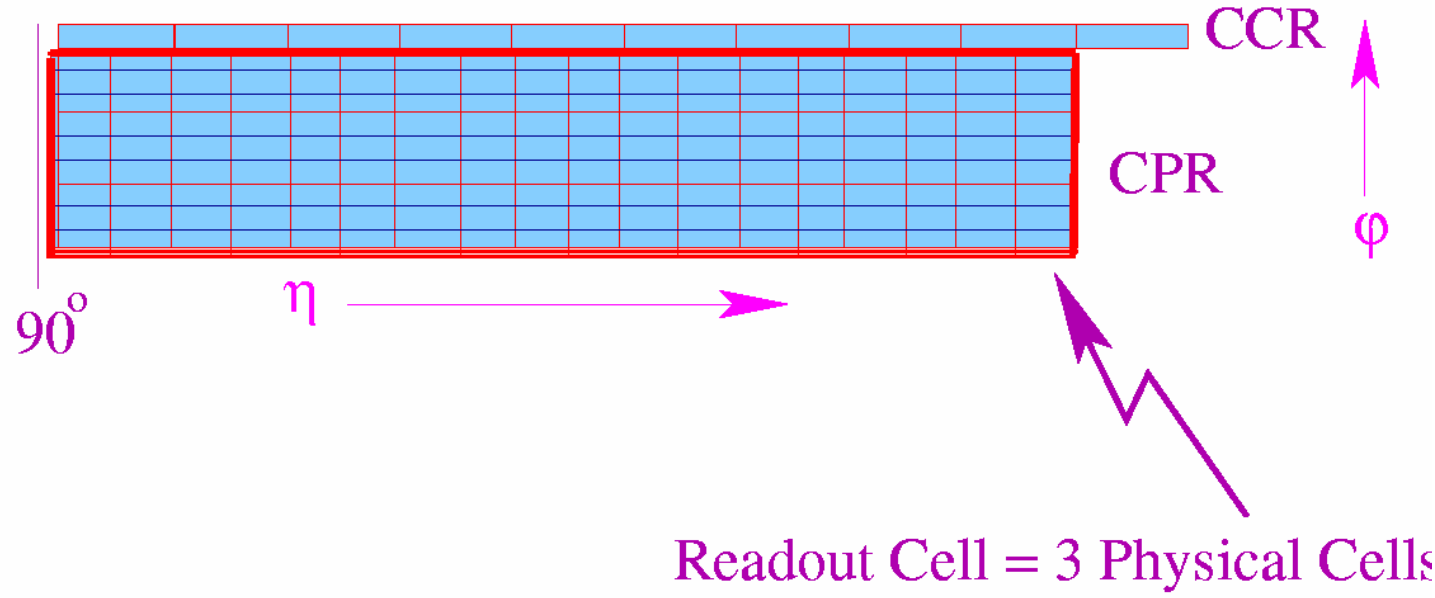
Also useful for New Physics searches involving Photons and Missing Et

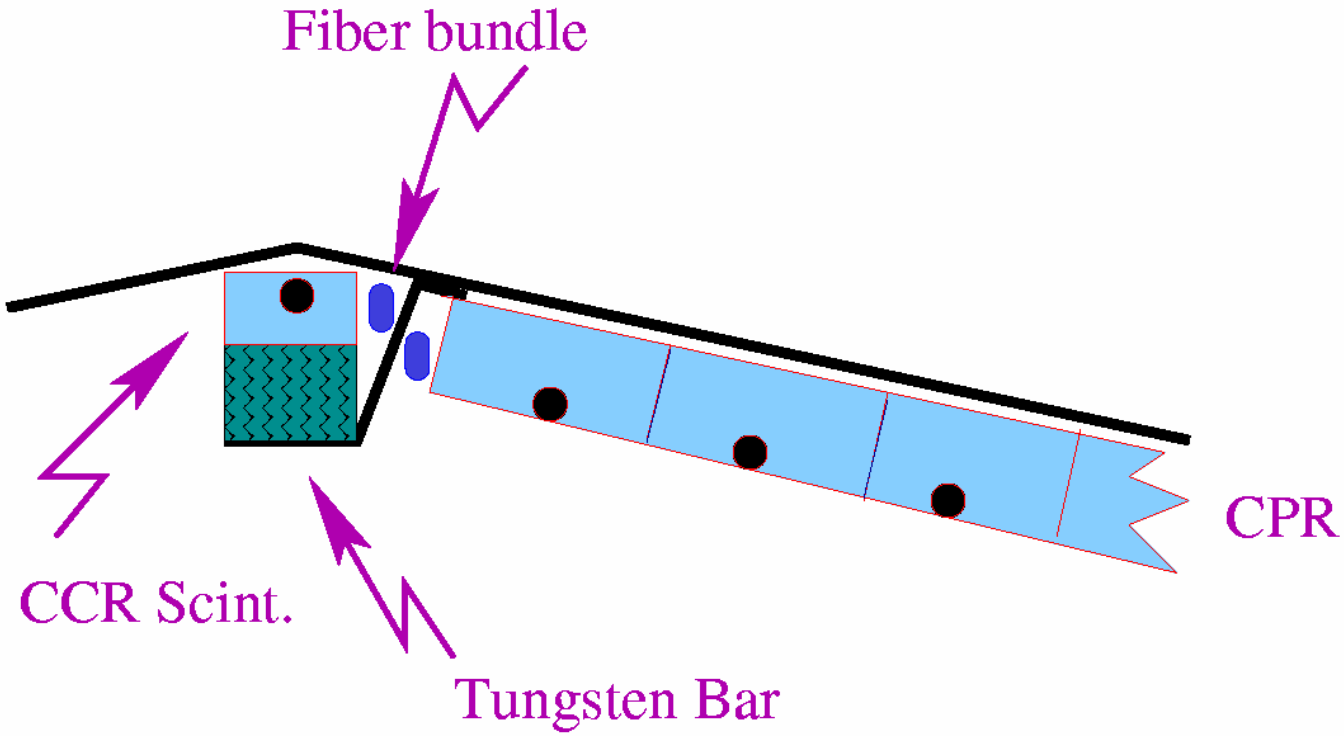
Can tag Photons hitting the crack which cause Missing Et

Can be added for an additional 6% of the total cost, and installed at the same time as the CPR

An Example from Run I of Crack Tagging, in this case the 2nd leg of a Z decay




CCR
CPR
φ
90°
η
Readout Cell = 3 Physical Cells


Fiber bundle
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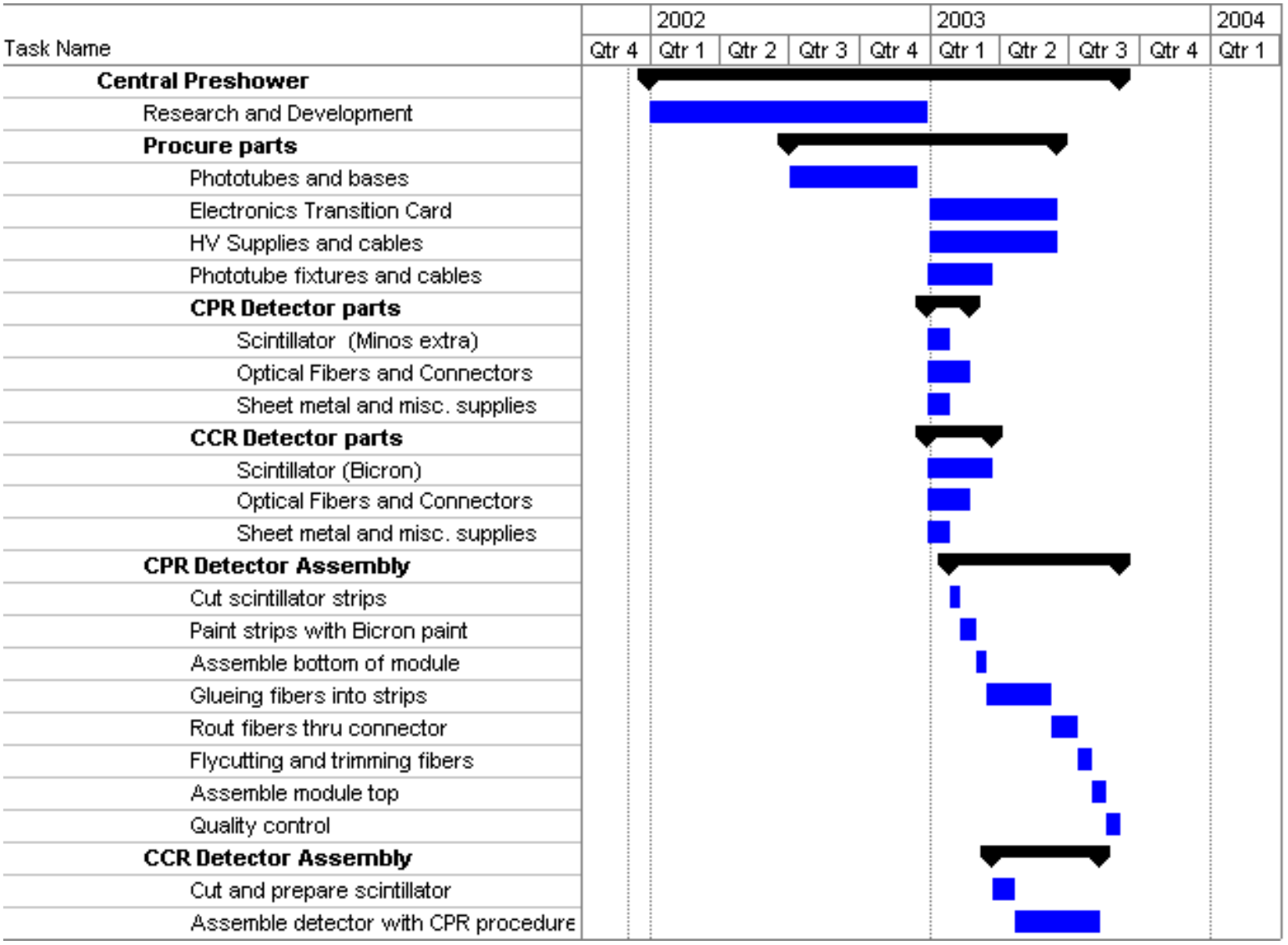
Task Name
2002
2003
2004
Qtr 4
Qtr 1
Qtr 2
Qtr 3
Qtr 4
Qtr 1
Qtr 2
Qtr 3
Qtr 4
Qtr 1
Central Preshower
Research and Development
Procure parts
Phototubes and bases
Electronics Transition Card
HV Supplies and cables
Phototube fixtures and cables
CPR Detector parts
Scintillator (Minos extra)
Optical Fibers and Connectors
Sheet metal and misc. supplies
CCR Detector parts
Scintillator (Bicron)
Optical Fibers and Connectors
Sheet metal and misc. supplies
CPR Detector Assembly
Cut scintillator strips
Paint strips with Bicron paint
Assemble bottom of module
Glueing fibers into strips
Rout fibers thru connector
Flycutting and trimming fibers
Assemble module top
Quality control
CCR Detector Assembly
Cut and prepare scintillator
Assemble detector with CPR procedure

Cost	$603K
Contingency	$154K
Cost+Cont.	$757K
U.S. (with Cont.)	$344K
Japan	$280K
Italy	$133K

Our piece of the $9.1M… (3.8%)

Contingency	$154K
Labor	$86K
R+D	$50K
Parts	$24K

Task Name	Total Cost
Central Preshower	**$603,083.68**
Research and Development	$50,000.00
Procure parts	**$459,864.00**
Phototubes and bases	$280,000.00
Electronics Transition Card	$15,000.00
HV Supplies and cables	$50,000.00
Phototube fixtures and cables	$5,000.00
CPR Detector parts	**$92,924.00**
Scintillator (Minos extra)	$0.00
Optical Fibers and Connectors	$89,424.00
Sheet metal and misc. supplies	$3,500.00
CCR Detector parts	**$16,940.00**
Scintillator (Bicron)	$10,000.00
Optical Fibers and Connectors	$6,240.00
Sheet metal and misc. supplies	$700.00
CPR Detector Assembly	**$73,219.68**
Cut scintillator strips	$4,307.04
Paint strips with Bicron paint	$7,178.40
Assemble bottom of module	$4,307.04
Glueing fibers into strips	$28,713.60
Rout fibers thru connector	$11,485.44
Flycutting and trimming fibers	$5,742.72
Assemble module top	$5,742.72
Quality control	$5,742.72
CCR Detector Assembly	**$20,000.00**
Cut and prepare scintillator	$10,000.00
Assemble detector with CPR procedure	$10,000.00

Conclusions

Preshower Detectors have played an important role in Run I physics

Role should expand in the Run II Higgs Discovery

Crucial for New Physics Searches with Photons

Baseline Design based on established techniques